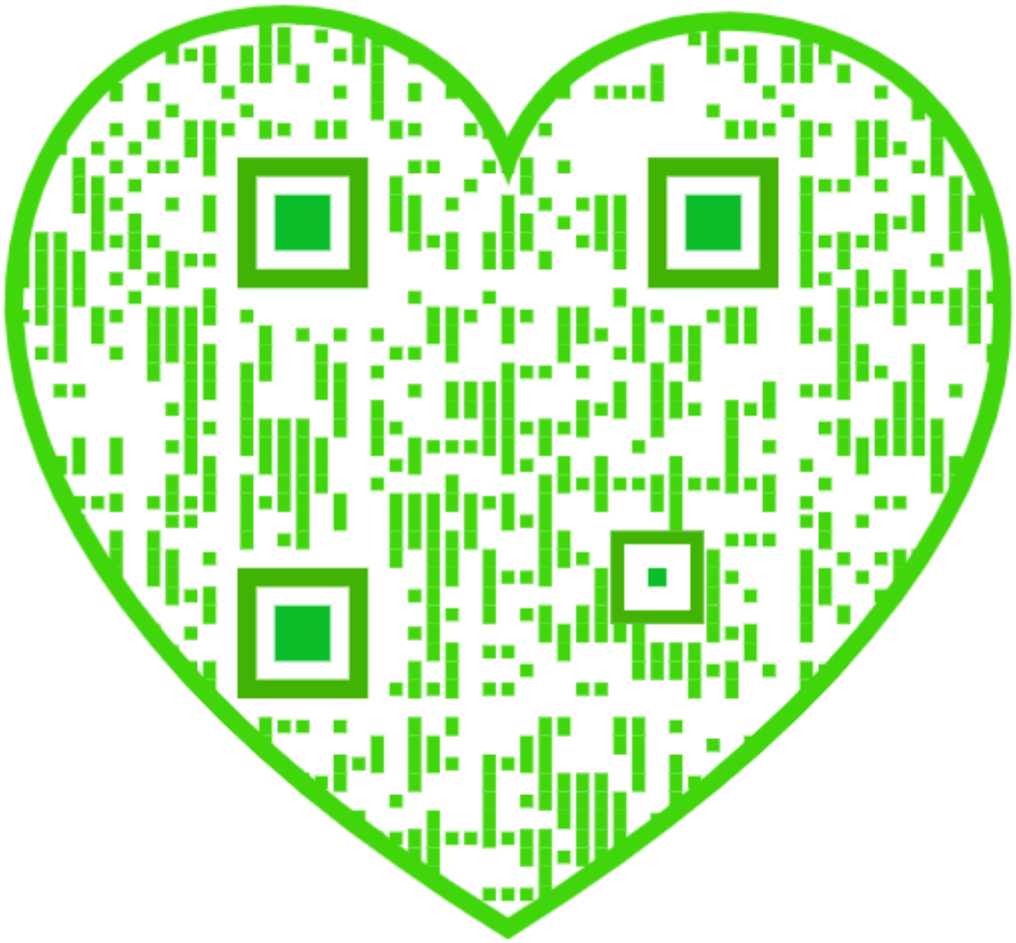

Bulletin No. 70.

West of Scotland Agricultural College.

Practical Advice to Beginners in Bee-keeping.

BY

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GLASGOW, 1916.

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ADVICE TO BEGINNERS IN BEE-KEEPING.

Bee-keeping is one of the most profitable of the minor rural industries. It is specially suitable for cotters, crofters, and small-holders, and while it cannot rank as one of the main sources of income on the average farm, yet it can be made one of the most remunerative side lines. To the horticulturist and market gardener it should make a special appeal. Further, it is an occupation which, from its nature, is particularly well-adapted for ladies. The initial capital required is small, the returns are quick, while the time and labour spent in operating a few colonies is amply repaid by the pleasure and profit to be derived from this fascinating pursuit.

From the national point of view, the industry deserves every encouragement. Honey, to the value of £46,921, was imported into Great Britain during the months of June, July, and August, 1915. This foreign honey is decidedly inferior to Scottish honey. The production of honey in Scotland is not equal to the demand, yet many hundred tons of nectar are annually lost, owing to insufficient colonies of bees. The money spent abroad could easily be retained at home.

Natural History.

A colony of bees in the summer consists of the following associated members :—the queen, the workers, and the drones.

Queen.

The queen, or mother, is the only perfectly developed female in the hive. She is a little longer in the body, and her movements are slow. She has a curved sting, which is used as an ovipositor. Her chief function is to deposit eggs, from which

emerge the other occupants of the hive—workers and drones. A good queen in the summer will lay from two to three thousand eggs per day. She will live from 3 to 5 years, but it is found that a queen in her second year has attained her maximum power of egg-production. To secure the best results from a colony of bees, it is therefore essential that a young queen should always be at the head of the colony. For example, a queen reared in July, 1915, is at her best during 1916. The queen deposits eggs of two kinds, those which give rise to workers and those which give rise to drones. Worker eggs are laid in worker cells, and under ordinary treatment produce worker bees, but under special treatment can be made to produce queens; drone eggs are deposited in drone cells.

Worker.

The worker bee is an undeveloped female. Workers are smaller in size than the queens or drones. They have a sting which deters many prospective bee-keepers from taking the subject in hand, but nature has given this weapon to the insect, not as a means of offence, but for the purpose of protecting itself from its natural foes. The workers have many enemies, and were it not for the sting, the race would soon become extinct. In a prosperous colony in the summer, the workers number from 40 to 60 thousand. They build the cells, collect the nectar and pollen, feed the young larvæ, and perform practically all the work in the beehive. Their span of life is short—from 6 to 8 weeks in the summer. During that period they work incessantly, and wear themselves out in their arduous labours. Those workers that are reared in the late autumn live through the winter, and perform a little work in the early spring. It takes about 3 weeks from the time the egg is laid to produce a worker bee. When the worker bee emerges from the cell it is very weak, and for the first week or so acts in the capacity of a nurse bee in the hive, *i.e.*, to feed the grubs or larvæ. After this period it is strong enough to take its place with the other workers in the fields. It naturally follows that, to obtain the maximum production of honey in a single colony, it is important to have the hive teeming with worker bees at a

time when nectar can be collected in the fields. This must be the chief aim of the bee-keeper. The greater the number of worker bees the hive contains at the right time, the greater will be the profit.

Drone.

The drone is the male bee. There are usually two or three hundred drones produced in all normal colonies. The number depends to a great extent upon the number of drone cells in the hive. Their function is to fertilise the young queens. At the close of the honey season, when their services are no longer required, they are turned out of the hive by the workers, and left to die. The drone does not possess a sting, and has no means of defending himself. Consequently he falls an easy prey to the workers. Neither has he any means of procuring his food in the fields, in consequence of his extremely rudimentary tongue. He is therefore dependent upon the worker for his sustenance. The drone is produced from an egg laid by the queen in a drone cell. The time occupied to produce a drone from the laying of the egg is 25 days. Drones from poor colonies are undesirable, and should not be encouraged. To improve the breed of bees, the bee-keeper should make a point of raising a few hundred drones only from those colonies which give the best returns.

Position and arrangement of apiary.

Beehives take up little room, and anyone with a small garden can keep a few colonies of bees. This does not imply, however, that any position will do for the hives, and on the selection of a suitable site will depend in a large measure the success of the bee-keeper. The site should be carefully selected. It should be dry and free from weeds. It should be sheltered from the north and east winds, and should face the south—which is the most favourable aspect. Shelter from the north and east winds will prevent much loss of life which usually occurs when the hives are placed in an exposed position. Spreading ashes on the surface will naturally assist in rendering the site dry, and in suppressing the growth of weeds, which harbour insect pests

inimical to the colony. The hive should be raised from the ground by means of legs, and if these are made to rest on bricks and tiles they will not decay so readily. Hives should not be too closely crowded. They should stand 6 feet apart, but if the available space is limited they may be set a little closer. A pathway at the rear of the hives is extremely useful, for then manipulations can be carried out without interference with those bees which are returning from the fields.

Hives.

The essential parts of a modern beehive are :—stand on legs, moveable floor board outer case, inner brood chamber, lifts, and roof, and surplus accommodation.

Hives of many designs are now in the market, but it is most important that the hives should be accurately constructed. If not, the bees will either use an excessive amount of propolis, or build combs in the ill-fitting spaces. Perhaps the most popular hive is the "W.B.C." hive—so called after the inventor, William Broughton Carr. It consists essentially of a stand, with legs, a floor board, a moveable brood chamber, containing 10 frames and a dummy frame, and outer brood case, roof, lifts, and chambers for the storing of honey. The advantages of this hive are :—it is easily kept clean; its capacity can be increased by the addition of more lifts; it is well adapted to the production either of "extracted" or "comb" honey; and with it operations such as "doubling" and "uniting" can be carried out with the greatest of ease. A hive of this type, however, is not suitable for bee-keepers who send their bees to the heather moors in Autumn, because it is more difficult to pack than a hive of simpler form, and entails greater expense in transit.

Hives with fixed brood chambers can be purchased more cheaply. But whatever type the bee-keeper adopts, he should endeavour to have all the hives made of similar size and shape, so that the relative parts are interchangeable. Such uniformity in the apiary will considerably simplify his work.

Hives should always be purchased new from manufacturers of bee appliances. It is poor economy to buy second-hand

hives at sales, because there is always the risk, and indeed the probability, that their late tenants have died from disease.

On receipt of the new hive, the bee-keeper should examine its component parts. The roof and lifts being removed, the following parts will be exposed :—section rack, shallow super, queen excluder, and quilts. Below these will be the brood chamber—a compartment containing 10 frames and a dummy frame; the former will be filled with sheets of "worker" foundation, and wired. The shallow super, section rack, and queen excluder are removed and placed under cover, for future use. The quilt is arranged over the brood chamber, and the lift and roof added. If the hive is not already painted on receipt from the dealer, it should be given two coats of paint. When dry, it will be ready for a swarm of bees.

Appliances.

When more than one colony is kept, the bee-keeper should also provide himself with a honey extractor, for extracting honey from combs; straw skep, to hive swarms, and super clearer to rid the honey chambers of the bees when removing the honey.

Purchasing Bees.

The beginner may start business by purchasing a swarm of bees from a local bee-keeper, or by buying an established stock. The first is perhaps the best and easiest method for the average beginner, for then the local dealer will assist the novice in placing the bees in the hive—though this is not a difficult operation. Swarms of bees are usually sold by weight, at 2s. 6d. to 3s. per lb. It is advisable not to purchase a swarm under 5 lbs. Whether or not honey will be obtained in the first season will depend on the time when the swarm is purchased, and the season. If the swarm be obtained in May or early in June it is possible, if the atmospheric conditions are favourable, to obtain a supply of honey the first season.

On the other hand, the apiarian may prefer to buy an established stock on 8-10 frames, from a reliable dealer in bees. If the stock is obtained early in the season, the bee-keeper may

rely upon securing a yield of honey the first season. A word of warning may be given here. In consequence of the prevalence of bee disease in the country, the bee-keeper should only trade with reliable dealers, and obtain, at the time of purchase, a guarantee of the healthy state of the bees.

Placing the Swarm into the Hive.

The swarm may be received either in a skep or in a box. If in the former, the mouth of the skep will be covered with a piece of cheese-cloth or coarse sacking, tied with string. The box, on the other hand, will be covered with a lid, consisting of perforated zinc attached to a wooden frame, which is held in position on the top of the box by means of screws.

In transferring the swarm to the hive, the beginner should proceed methodically. The entrance should be opened to its full width. A temporary stage in the form of an inclined plane leading up to the hive entrance is erected. This consists of a long board, one end resting on the alighting board of the hive, and the other end on the ground. Over this board a white cloth should be evenly laid. Previous to transferring the bees from box or skep, the bees should be given a little smoke. Having removed the cover, the operator should now lift the box or skep, turn it upside down, and with a sharp jerk dislodge the swarm on to the improvised landing stage. The natural inclination of bees is to run upwards, and in a little time they will all be safely in the hive. A sharp watch ought to be kept to see that the queen is safely in the hive. If the weather be cold at the time, the bees will not run quickly, but a little smoke will have the desired effect.

When an established stock has been purchased, the bee-keeper will find it a simple task to remove the combs with bees from the travelling box into the frame hive.

Handling and Manipulating Bees.

To manipulate bees, the operator must necessarily have a black net veil, to protect the face from stings, and a smoker,

to subdue and control the bees. The veil should be broad enough to stretch round the rim of a straw hat, and long enough to allow the free end being well tucked under the collar of the coat. A piece of elastic sewn round the top of the veil will hold it tightly in position around the crown of the hat. As regards the smoker, the best smouldering materials are corrugated-paper, old bags, corduroy, and decayed wood; any of these, when ignited, will, by the action of the bellows, give off a good column of smoke. The smoker, once ignited, may be kept alight when not in use by standing it vertically with its nozzle upwards.

All manipulations should be performed gently and slowly. Clumsiness only serves to irritate the bees. To inspect the colony, a few puffs of smoke should be blown in at the entrance, and, after allowing 2 to 3 minutes for this to take effect, the bee-keeper should take up his position at the back of the hive, and gently remove the roof. The lift is next taken off, without any jarring effect. Following this, the wrappings over the brood chamber, with the exception of the quilt next the bees, are removed *en bloc*. In removing the quilt, the corner should be slightly raised, and a few whiffs of smoke blown into the hive. This process should be continued until the quilt has been entirely removed. The smoke frightens the bees, and they instantly rush to their cells and partake of their own honey, after which they are exceedingly docile. An examination of the brood chamber should not occupy more than a few minutes. The bee-keeper should first of all remove the "dummy" from the back or the side of the hive. This is a piece of wood, shaped like a frame, and when removed enables the bee-keeper to have more space at his disposal to lift out the frames. Each frame should be taken out evenly and gently, care being taken not to crush any of the bees during this operation. When putting back the frames, the same precaution should be observed. If the bees get at all irritable or out of hand, they can be controlled by the application of a little more smoke.

No colony should be inspected when the thermometer is below 60 degrees Fahrenheit, or the brood will be chilled. Bees can be more easily handled on warm, sunny days than in cool or windy weather.

If the bee-keeper should happen to get stung at any time, he should push the sting from the flesh by the finger nail. Any attempt to pull out the sting by the thumb and finger simply results in sending more poison into the flesh. The poison—formic acid—is rarely dangerous, and in the course of time the bee-keeper becomes more or less immune to the same.

It is proposed, in a further bulletin, to give advice on other aspects of the subject.

Lifting author.
4/10/26

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The West of Scotland Agricultural College.

PRELIMINARY REPORT

ON

ISLE OF WIGHT BEE DISEASE.

BY

JOSEPH TINSLEY, B.B.K.A (First Class).

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PRELIMINARY REPORT ON THE ISLE OF WIGHT BEE DISEASE.

By Joseph Tinsley, B.B.K.A. (First Class).

The Isle of Wight Bee Disease is a highly contagious and deadly malady which affects bees and probably also wasps. This disease, which has long been known on the Continent of Europe, first made its appearance in Britain in 1904; in this year an outbreak was reported in the Isle of Wight, hence the name "Isle of Wight" Bee Disease. It spread with alarming rapidity throughout the country. Few districts or hives escaped its devastating effects, and many beekeepers suffered serious loss. By the year 1912 the stocks of bees in England were reduced to a mere fraction of their original proportions. In some seasons the disease would appear to have been more fatal and to have spread more quickly than in others.

By the year 1913 the Isle of Wight disease was generally established in Scotland; from the southern counties, where it first appeared, the epidemic quickly spread to the northern reaches, leaving death and destruction in its train. In many districts not a single colony escaped, but in certain isolated cases, as in the Kilmaurs neighbourhood, the native bees failed to contract the disease. Such bees appear to possess a natural immunity, and consequently are of great value as foundation stock.

Cause of the Disease.

The first scientific report relating to the etiology of this disease was prepared by Mr. A. D. Imms, and was published in the *Journal of the Board of Agriculture* for June, 1907. The second, written by Dr. Malden, appeared in the *Journal* for February, 1909. The third, by Drs. Graham Smith,

Fantham, Porter, Malden, and G. W. Bullamore, was published as Supplement No. 8 to the *Journal*, and was, in effect, an interim report on the investigation, the final results being published as Supplement No. 10 to the *Journal of the Board of Agriculture*, July, 1913. References to the subject were also made in the Report of the Intelligence Division of the Board of Agriculture and Fisheries, Part 11, for the years 1909-12.

In his report of 1909, Dr. Malden ascribes this disease to a bacillus (*Bacillus pestiformis apis*), but in the two papers published by Dr. Graham Smith and his collaborators the disease is definitely stated to be due to a parasitic protozoon (*Nosema apis*). In the 1913 report it is stated : " No species of bacteria constantly associated with the Isle of Wight disease has been found, and *B. pestiformis apis*, which is frequently present in diseased stocks and was at one time thought to be the causal agent, is not pathogenic in pure culture. Bacteria, however, may play an important secondary part in producing the symptoms when the resisting powers have been lowered by the action of *Nosema*."

The disease has more recently been investigated in Scotland by Dr. J. Rennie, of Aberdeen University, and Mr. J. Anderson, M.A., B.Sc., of the Aberdeen College of Agriculture. As a result of considerable experiment and investigation, they conclude that the causative agent is not *Nosema apis*. While admitting that spores of *Nosema apis* may frequently be observed in the bodies of diseased bees, yet they believe that it is not the direct cause of the disease, and that the real source of the trouble is to be found in some other factor which has not yet been determined.

The origin of the Isle of Wight disease has also been made the subject of inquiry by the Beekeeping Department of the West of Scotland Agricultural College. While we do not hold ourselves committed to either of the above views, it certainly does not appear to us that *Nosema apis* is the universal cause of the disease familiarly known as the Isle of Wight Bee Disease. After a thorough examination of the bodies of thousands of bees which have undoubtedly perished from the

Isle of Wight (or at least from a disease all of whose diagnostic features are the same as those of Isle of Wight), we have rarely found the spores of protozoa as described by Dr. H. B. Fantham and Dr. Annie Porter, even after a minute examination of the chyle—stomach and fæces. On the other hand, the stomach contents and the excrement of diseased bees have shown the unfailing presence of masses of bacteria, and we are of the opinion that these are not without special significance.

The result of our work on this aspect of the subject will be published in a later report.

Spread of the Disease.

Apart from the natural agencies which favour the spread of epidemic diseases in general, and which have undoubtedly been operative in the present instance, there is direct evidence of the Isle of Wight disease having been introduced into the various districts of South-West Scotland by the importation of bees from infected areas. It is quite a common practice for beekeepers in Scotland to purchase swarms of bees from the South of England about the month of May, so as to ensure a strong colony for the heather harvest. Many such swarms have come from districts where the Isle of Wight disease was prevalent. These imported bees, though apparently healthy, were in most cases suffering from the disease in its initial stage, when diagnosis is difficult even to the specialist. In the same way, the purchase of queens with attendant workers from infected districts has also materially assisted in spreading the disease.

Once the disease has been introduced into any district it quickly spreads, and sooner or later invades every hive. The infection may take place in several ways.

(*a*) When a colony becomes infected, the stock rapidly dwindles on account of the high mortality incident on the disease. The result is that the surviving members of the colony are too weak to protect the hive against the invasion of robber bees, who carry off the honey and infected material. Not infrequently, also, the dispossessed and overpowered bees

join forces with the invaders, and accompany the robber bees to their own hives. This introduction of infected material, and the association with unhealthy bees, cannot fail to establish the malady in the hives of the reivers, and so it is a case not only of *vœ victis*, but also of *vœ victoribus.*

(*b*) It is also a well-known fact that bees may enter strange hives in mistake: this particularly happens, during summer, where there is a superabundance of nectar. Such alien bees, if suffering from Isle of Wight disease, can undoubtedly introduce the disease into hitherto unaffected colonies.

(*c*) The practice of sending bees to the heather has also been an important factor in spreading the disease. In this way colonies from many different districts have been brought together on the heather moors. There is no doubt that some such colonies harbour the Isle of Wight disease, probably unknown to the owners, though in some cases colonies which were actually known to be affected have been sent to the heather by beekeepers who fancied a change of environment would result in a cure. When these bees are liberated at the heather after their long journey thither, they frequently mix together, and, in the confusion, often enter the wrong hive. This mingling of members of different hives must be a fruitful cause in the spread of the disease. Observation shows that many colonies suffering from the initial stages of the Isle of Wight disease, when sent to the heather, die there. Even if some do survive the heather season and are brought back to the old home, the evil is only aggravated, for they now become a menace and a plague to their native district.

Symptoms of the Disease.

If one observes a healthy colony in the summer time, the bees will be seen to enter and leave the hive in rapid succession; the laden bees returning from the fields and the workers setting out to collect pollen and nectar do not loiter at the entrance to the hive. They have no time to waste at the gates. They are too busy. But with the onset of the disease there is a marked difference in the behaviour of the bees. They have no longer any desire to toil in the fields.

They seem to have lost their characteristic energy. They crowd round the entrance of the hive, occasionally clustering and displaying a general appearance of listlessness. This lack of vitality is the first noticeable phase of the disease.

A peculiar feature of the wings—the so-called split wing—is often observed in bees suffering from Isle of Wight disease in its early stages. Normally the bee, when in the act of flight, unites the fore and hind wings together so that the two wings on either side of the thorax act as one. (This union is brought about by a series of hooks on the anterior margin of the hind wing engaging a series of catches on the posterior border of the fore wing.) But when the bee contracts Isle of Wight disease this power of union is often lost, and the wings appear quite separate. It should be observed that this split wing appearance, though quite characteristic, is not in itself diagnostic of the disease.

Occasionally a sick bee may be observed drawing its posterior legs over the abdomen—as if the bee realised a sensation of pain in that part.

With the advance of the malady the "crawling" symptoms so typical of the Isle of Wight disease become patent. The diagnosis is now plain, and there can no longer be any doubt regarding the nature of the disease. The crawling symptoms are first noticeable in the sick bees after they have been confined to the hive for two or three days owing to inclement weather. A return to genial conditions or a sudden burst of sunshine will induce the bees to emerge from the hives in great numbers. It will then be seen that many of them have lost the power of flight; some drop down on to the ground beneath the hive where they cluster; others come to earth after a flight of only a few yards. If the hives are situated on grass the bees may be seen crawling up the stems to try and reach a higher position. If the hives stand on ashes or gravel, the bees, by laborious efforts, make their way towards the hive, up the legs of which they crawl in an effort to reach home. The great majority of these bees die, and the ground in the vicinity of the hive becomes strewn with their dead bodies.

An examination of one of these crawlers will show the abdomen greatly distended. This is due to a retention of the fæces, which the insect seems powerless to void. The slightest external pressure will cause a rupture of the intestine and the issue of its accumulated contents. The discharge is usually of a dirty yellow colour, but the colour will be related to the kind of pollen which the bee had previously consumed.

Occasionally the sick bees are able to excrete a portion of the fæces, in which case the front of the hive becomes spotted with the voidings. This gives the appearance of severe dysentery—a malady, however, which does not appear to have any relation to the Isle of Wight disease.

The interior of the hive presents no abnormal appearance in the early stages of the disease. There is no soiling of the combs, and the whole hive appears to be in a healthy and flourishing condition. But with the advance of the disease the soiling of the combs attracts attention. The heavy mortality among the workers so seriously reduces the numbers that the temperature of the hive is lowered and part of the brood dies from lack of heat. After the extinction of the other members of the colony, the queen herself dies. It has been suggested that her death is due to exhaustion and not to the disease. This aspect of the subject, however, will receive attention in a future report.

In winter months the presence of Isle of Wight disease in bee colonies is difficult to determine, for now the bees are in a semi-dormant condition, and are mostly confined to the hive. They rarely fly except on mild days, and consequently there is little opportunity for satisfactorily diagnosing the disease. To make an inspection now would necessitate opening the hive, and this act, on account of the lowering of the temperature, would be harmful to the bees and to what brood there may be. And so, even if the disease could be recognised, no steps can now be taken to check its course.

The beekeeper should know that a colony of bees may enter into winter quarters apparently healthy, strong in numbers, headed by a young queen, and with plenty of food reserves, and yet the total colony may die out during the winter months

from Isle of Wight disease. But as bees may also die during winter from purely natural causes, it becomes important, from the point of view of the well-being of the apiary, to determine to what particular agency, the death of a colony has been due.

In the absence of disease, the extinction of a colony in winter may be due either to loss of queen or to lack of food. In the former case, there will be few, if any, worker bees left alive in the spring: the colony will have perished owing to there being no births to compensate the deaths. On the other hand, a diminution of a colony through lack of food is evidenced by the dead bees clustered on the combs, many with their heads inside the cells. Some of them may be noticed with their tongues extended. The cells will be empty of honey and sugar syrup, but there will be brood in various stages if the bees were alive until the end of January. In neither of these cases is there any soiling of the combs, and there is no objectionable odour.

If, however, the death of the colony has been due to the Isle of Wight disease, the dead bees will be found scattered over the combs and on the floor of the hive; there will be abundant supplies of food and also a small batch of brood, showing that the queen performed her duties up to the last. But the combs and also the interior of the hive will be soiled with the excreta of the bees. There is a further important distinction in the bodies of bees which have died from natural causes and those which have perished from Isle of Wight disease. Normally the bodies of dead bees shrivel up soon after death, and the abdominal contents will be found to be perfectly dry. But in the case of death due to Isle of Wight disease the intestine is filled with a fluid which gives off a very foul odour. Provided that the body wall is not ruptured, we have found that the intestinal contents will retain their fluid condition for a period of six months. On exposure to air, however, this liquid mass quickly becomes solid.

Infection Experiments.

To illustrate the facility with which the disease can be

transmitted, the following experiments were carried out at our Research Apiary :—

(*a*) About 200 bees crawling on the ground, and showing abnormal distension of the abdomen, were collected, chloroformed, and the liquid contents of the intestine removed. This fluid, mixed with a pint of sugar syrup, was systematically fed to healthy colonies until the crawling symptoms were evident. The colonies thus fed contracted the disease in a virulent form in from three to six weeks.

(*b*) Colonies in the last stage of the disease were united to healthy colonies by placing all the sick bees, combs, brood, and stores in the form of an additional brood chamber over the top of unaffected stocks. (The queens in the diseased colonies were removed previous to the union.) It took from 4 to 6 weeks to transmit the disease by this method.

(*c*) The entire brood chambers from colonies that had recently died from Isle of Wight disease were placed over the brood chambers of healthy colonies (as in the operation of uniting or doubling). The infected brood chambers, which contained fæcal matter in abundance on the frames and over the combs, and many dead bees in the cells, were not interfered with. The chamber was necessarily used by the bees as a honey super. This compelled the healthy bees to remove the dirt and debris from the soiled combs, and brought them in direct contact with disease-infected material. The time of infection in this case was longer—from 6 to 8 weeks.

(*d*) Combs from colonies where the bees had recently died from the disease were broken up and mixed with water. The extract, after being strained through coarse cloth, was mixed with sugar syrup and fed to healthy colonies. In this case infection was even slower—from 8 to 10 weeks.

(*e*) The debris and fæcal matter of the hives of several colonies that had died from Isle of Wight disease was collected by scraping floor boards, frames, &c. This was mixed with water and fed with sugar syrup to healthy colonies. It is doubtful if, in any single case, this method of infection was successful. It should be mentioned that the material was obtained from the hives some time after the death of the colonies, varying from two to twelve months. Presumably the organisms causative of the disease have little vitality outside the bee body, and are killed out by exposure to the atmosphere.

(*f*) Honey extracted from combs upon which diseased bees had died during the winter was given to healthy stocks. These bees did not contract the disease.

Other methods of bringing about infection—such as placing sick bees, numbering from 50 to 500, in healthy colonies; re-queening a healthy colony with a queen from a diseased stock; transferring larvæ and brood from an unhealthy colony to a healthy colony—were tried many times. The results were, in the main, inconclusive.

Although some of the latter methods of infection did not always prove successful, yet from a study of the history and spread of the disease, and of the results of the first experiments outlined above, we must regard the Isle of Wight disease as highly contagious, and beekeepers will be well advised to pay every attention to disinfection of hives and appliances, and to limiting the spread of the disease.

Preventive Measures.

Disinfection of Hives, Appliances, &c.

Hives in which bees have died from the plague should be scraped and thoroughly washed inside and out with a strong solution of formalin (1 in 60). When a large number of hives have to be disinfected, fumigation, properly carried

out, is quite effective, and saves much time and labour. Proceed as follows. Remove the interior chambers, place a lighted formalin candle on the floor of the hive, close up the entrance of the hive, also the cones in the roof. If the latter does not fit tightly, place a sack or covering over it to prevent the escape of the fumes. Leave the gas in contact with the hive for six hours. Finally, wash the exterior of the hive with formalin water (1 in 60).

During a bad attack of Isle of Wight disease many bees will die on the floor and around the stands of the hive, hence it is only reasonable to suggest that, if a fresh position cannot be given to the new colony, the ground on which the hive stands should be liberally disinfected with lime or chloride of lime. All infected combs containing brood and unsealed larvæ should be destroyed. Brood combs that contain honey should be smashed up and the honey used for home consumption. Such honey should not be used for feeding bees.

Frames from a diseased hive may be used again if properly disinfected. To ensure this, first clean out the usual saw-cut in the top of the frame where the foundation is inserted, then scrape away any fæcal matter from the frames, and finally, before placing in the disinfectant, thoroughly scrub them with soap and hot water.

In the same way, empty brood combs, super combs, and sections of comb, can be rendered safe for further service, but here disinfection with formalin vapour is quicker, cheaper, and quite effective. The combs should be placed in a box or other air-tight receptacle, and exposed to the fumes of a sulphur or formalin candle.

Apart altogether from the incidence of the disease, it is an excellent plan to disinfect with formalin all apiary appliances such as feeders, smokers, and queen excluders. Quilts steeped in formalin solution and dried can be safely used again.

Disinfection of the exterior of hives is most easily effected by spraying the outside of the hive with the same disinfectant. A large syringe is very convenient for this purpose. Any of the solution dripping from the outside of the hives will assist in disinfecting the ground on which they stand.

Remedial Measures.

In all our experiments with so-called remedies and cures, it should be understood that the bees, during the period of the experiment, were not confined in any way, and that they were distinctly infected with Isle of Wight disease before any treatment was tried. A number of colonies of diseased bees were purchased from various beekeepers for the purpose of experiment.

Izal.—This proprietary article, advertised as the "Modern high-power germicide, and a reliable remedy against foul brood and Isle of Wight disease," was supplied to (1) a colony suffering from Isle of Wight disease in the initial stage; (2) a colony with a mild attack; and (3) a colony in the last stages of the disease. The Izal was administered both in the food and as a spray with water or sugar syrup, the directions of the manufacturers being carefully followed. In no single case was it effective.

Bacterol.—This bactericide is stated to have a destructive action on spores, and its use has been recommended for Isle of Wight disease. Similar experiments were carried out as with Izal, and the results were the same—purely negative.

Dioxygen, Phenol, Quinine, Formalin, Sulphur, *Milton*, &c., also aperients, were experimented with, but all gave negative results. Indeed, it is doubtful whether a medicine or drug exists which, when administered to bees suffering from the Isle of Wight disease will effect a cure. We think little is to be gained by the search for a so-called specific among medicines or chemicals. Recently Flavine has been tried, but without any good results.

The most promising results so far obtained by us have been got from the employment of a pure culture of *Bacillus Bulgaricus*. This is the organism recommended by Prof. Metchnikoff as a remedy for intestinal troubles. It acts as a scavenger of the intestine, and displaces putrefactive and injurious organisms in the bowels.

The method was first tried by us during the latter part of July, 1916, at the suggestion of Prof. Renwick H. Leitch (Dairying Department, West of Scotland Agricultural College), who also supplied the culture. The culture was mixed with syrup and fed to the bees by means of spraying. The bees will readily take the food in the feeders, but spraying is the quicker method. The treatment was tried on a swarm of bees which arrived from the South of Scotland on the 27th July, 1916, and which on arrival almost immediately developed a virulent attack of Isle of Wight disease. The swarm weighed seven pounds. It was placed on ten frames, which had previously been fitted with brood foundation. In the course of two days the whole of the ten combs had been built, the cells being filled with nectar, pollen, and eggs of the queen. On the 30th July it was noticed that, on the ground in front of the hive, the bees were crawling about in hundreds. The entrance to the hive was closed the same evening, and the colony removed from the Holmes Farm Apiary (where it was first placed) to the Research Apiary—about 2 miles distant. On the bees being liberated the following day, external indications of the disease were even more pronounced, probably owing to the confinement of the bees during transit. By this time there was a disease in the population of at least 30 per cent The *Bacillus Bulgaricus* was administered on the evening of their arrival, by spraying both at the entrance and over the tops of the brood combs. The number of crawlers decreased each day, and finally disappeared altogether after a fortnight's treatment. The culture had a noticeable effect, not only on the expulsion of the fæcal accumulation, but also on the nature of the discharge. There is less tendency for the excretion to solidify; after it has been voided it rather tends to break up. Ordinarily the colour of the fæces in cases of Isle of Wight disease varies in summer from a light yellow to a dark brown. The *Bacillus Bulgaricus* changes it to a dark grey. The colony thrived during the autumn and winter, and remained alive until early in the spring.

It would appear, from the supplementary evidence of

experiments with other colonies, that this treatment, while it may not result in an absolute cure, will at any rate for a time repress the disease and even check mortality during the summer months. It is possible that, if the treatment be begun early and be continued systematically, it may entirely ward off the disease. There are certainly possibilities in the use of this culture, and further experiments are being carried out.

Breeding to Produce Immunity.

The real remedy for this disease lies in the production or development of strains of bees immune to it. It is a well-known fact that some strains of bees are highly resistant to the Isle of Wight disease, and can only be caused to contract it by the direct administration of considerable doses of infected material.

During the course of our infection experiments we observed that certain selected colonies failed to contract the disease even under conditions most favourable to infection. Their powers of resistance were so marked that we decided to retain them for the purpose of raising queens and the increase of stock generally, and further to use them as a basis for our experiments in the production of disease-resistant strains of bees. In this attempt to produce immunity, purely scientific methods were employed. The scheme, which started on a limited scale, has now been greatly extended, so that an apiary of considerable size has been built up at our head-quarters, Kilmarnock.

To determine whether the bees so bred are largely disease-resistant, colonies were placed, during 1916, in the very heart of districts in Ayrshire where the disease had been rampant for five years, and where all attempts at re-stocking had utterly failed. During last season (1917) each experimental colony gave a swarm and a cast, or second swarm, and in addition produced a good yield of honey. Up to the present, the colonies are quite free from disease.

In our efforts to raise immune strains we have experimented very largely with foreign bees. Generally speaking, we have

not found them to be disease proof, although, when attacked by the disease, they do not succumb nearly so quickly as native stocks. Particularly was this the case with Dutch, Italian, American, and Punic bees. There is no doubt that judicious crossing of foreign bees with our own tends to increase vigour and disease-resisting powers. We observed this particularly in the case of Dutch crosses.

It will also generally be found that foreign bees imported from districts which are low-lying and wet, and where there is a lack of sunshine, will give the best results in withstanding the disease; at least this has been our experience.

With regard to resistant strains of native origin, it may be interesting to observe that the smaller-sized bees appear to have greater disease-resisting powers than larger-sized bees. These hardy little bees are often to be found living in trees in woodlands, and in the roofs of castles and houses.

The work on the production of immune strains of bees is being continued, and it is hoped that we shall shortly be in a position to re-stock disease-swept districts in the College area from our apiary at Kilmarnock.

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4/10 1926

The West of Scotland Agricultural College.

SOME BEE DISEASES

—BY—

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(Lecturer on Beekeeping).

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SOME BEE DISEASES.

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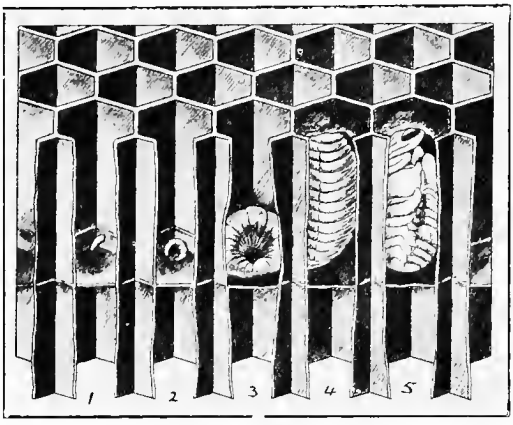
Lecturer on Beekeeping (West of Scotland College of Agriculture).

OF all the diseases with which the beekeeper has to contend, probably the most common is that known as Foul Brood. The disease has been so named because of the foul smell which emanates from the dead brood. But as death of the brood, even when accompanied by putrefactive changes, may be due to different causes, the name is a general one. In this country the term Foul Brood is commonly applied to three different diseases, viz., European Foul Brood, caused by *Bacillus alvei*; American Foul Brood, caused by *Bacillus larvæ*; and Sac Brood. In the case of Sac Brood the causative agent has not yet been determined.

Foul Brood (Bacillus alvei).—Before we proceed to examine this disease in detail it may be well to recall the social conditions under which bees live. The rapid manner in which the infection is transmitted will then be the more readily appreciated. In the first place, a colony of bees varies in number from 20,000 to 40,000 individuals, and yet takes up relatively little space. Again, all the cells in the hive—those in which the young hatch out and those in which the honey is stored—are made from wax elaborated by the bees themselves. Thirdly, food is prepared in the bodies of the nurse bees for the sustenance of the larvæ, while during exceptional periods food is conveyed from the workers to the queen direct. Finally, the cleanliness of the hive is effected by the workers themselves carrying out of the home any objectionable material. It will thus be seen how easily a disease of an infectious nature spreads in a colony of bees, and how important it is that the beekeeper should be able to diagnose all diseases in their initial stages in order to prevent rapid spreading and obviate financial loss.

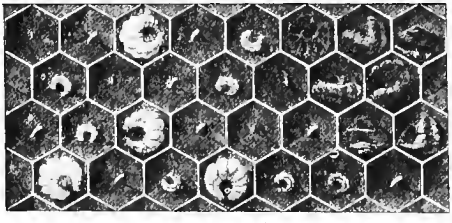
Symptoms.—If we examine a normal brood comb we will find eggs, larvæ, and brood in all stages of development. Close inspection will show that eggs newly deposited by the queen stand upright in the cell. On the second day these same eggs rest at an angle of 45 degrees. On the third day each develops into a small grub curled up like the letter "C." These grubs are pearly white in colour, and

present a glistening appearance as they lie flat on the bottom of the cell. As a result of the special feeding given them by the



Development of the Bee.

attendant workers they grow rapidly, so that by the seventh day they present a white and plump appearance. Development takes place rapidly, and on the ninth day the cell containing the developed larvæ is covered over with a porous capping. On the twenty-first day the worker bee bites its way through the capping and takes its place in the hive. These are the conditions in a healthy colony, but in a colony in which Foul Brood occurs the first noticeable difference is in the condition of the larvæ. Instead of all the grubs being white and plump and curled up like the letter "C," as they would normally appear, they will be observed to take up very irregular positions. Some will be almost perpendicular, while others will be horizontal. Instead of appearing pearly white, the grubs will be coloured a faint

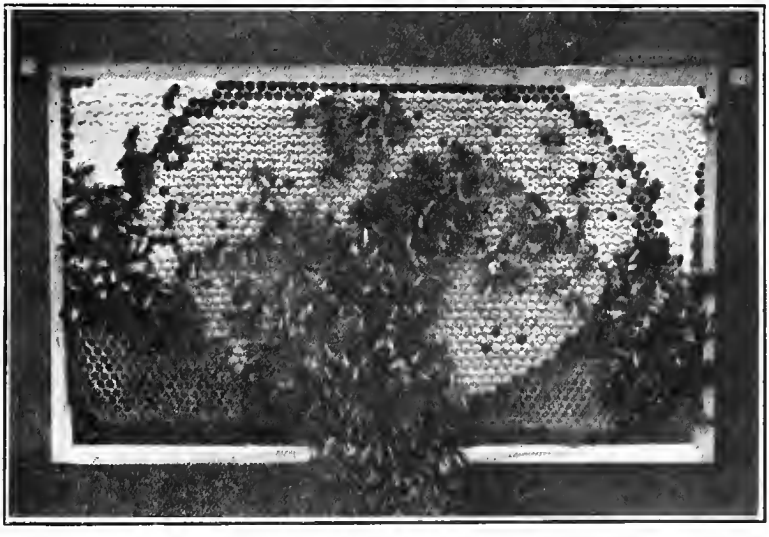


Early Stages of Foul Brood in Seven Cells.

buff or yellow. At this initial stage of the disease a cure can usually be effected if the colony is fairly strong, but immediate attention is necessary if the treatment is to be successful.

Treatment of Foul Brood in initial stage.—The queen should be destroyed and a new queen of a healthy variety, such as Dutch or Italian, substituted. The colony should be given a complete change of hive. This is imperative. All the old combs should be taken away and burnt, and should be replaced by frames fitted with sheets of worker foundation. The introduction of a fresh queen, the change of hive, and the addition of new combs will materially assist in checking the disease. The colony will be reinvigorated, and the stamina of the future inhabitants of the hive will be greatly improved.

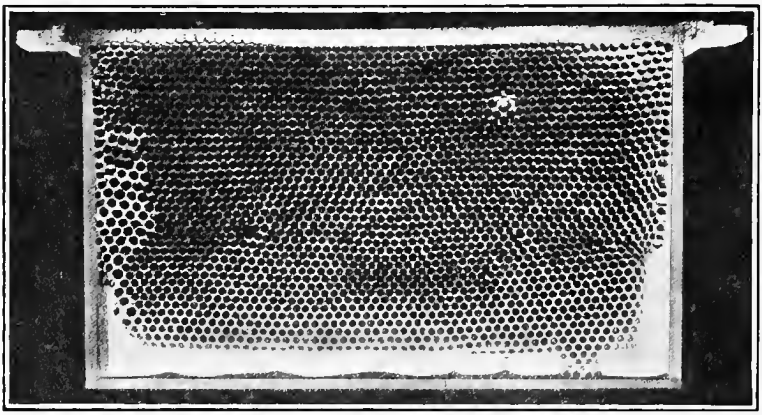
In consequence of the infectious nature of the disease, all operations should be carried out in the evening, when the bees have finished flying for the day. The beekeeper may himself be a means of spreading the infection by carrying the spores of the disease on his hands and clothes. Disinfection of everything that comes into contact with the hive or hive contents should be carefully carried out.



Comb of Brood in a Healthy Condition.

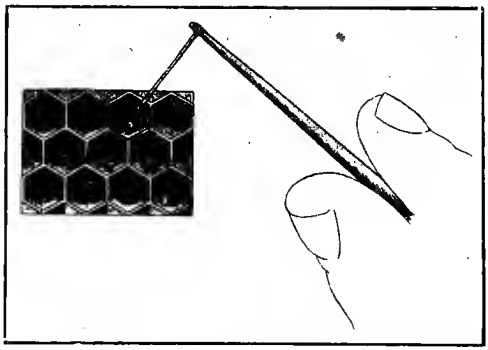
Second stage of the disease.—If the beekeeper has failed to observe the malady in the initial stage he will soon be confronted

with a much more virulent condition of the disease. By this period the bees will have sealed over many of the grubs that were attacked by the disease in its early stages. The cappings of the brood cells,



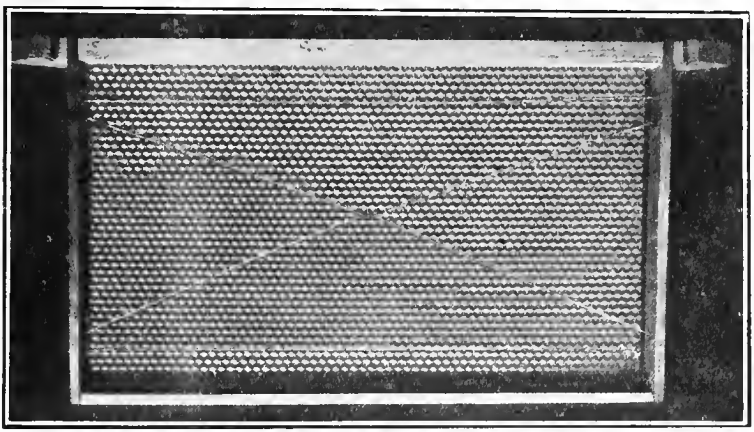
Empty Brood Comb requiring renewing.

instead of being light brown in colour and convex in appearance, will be dark brown and flat or indented; occasional cells may have minute perforations in the covers. If a match is pressed into one of these cells and then withdrawn, a brown, ropy, tenacious mass will adhere to the wood, and an unpleasant odour reminiscent of the glue-pot will be observed. The colony will diminish rapidly in numbers as a result of the high death-rate in the cells.



Foul Brood. Ropy Stage (B. alvei).

Treatment of Foul Brood in the second stage.—If the colony is in a weak condition the bees should be destroyed at once. This will save the beekeeper from further financial loss by preventing other colonies becoming infected. But if the colony is fairly strong, remedial measures should be applied forthwith. The queen should be killed. In order that the whole of the healthy brood still in the hive may be brought to maturity it is advisable to keep the colony without a queen for at least eleven days. Immediately the colony realises its queenlessness it will endeavour to raise a queen from the larvæ in the hive. To prevent this, make an examination of the colony about the seventh day after the destruction of the queen, and remove all queen cells in the course of construction. On the eleventh day, when practically all the healthy brood will have hatched, the bees should be brushed or shaken off their combs and placed in a clean hive. This hive must be fitted with frames into which foundation has been inserted and wired. A new queen is then given, Dutch or

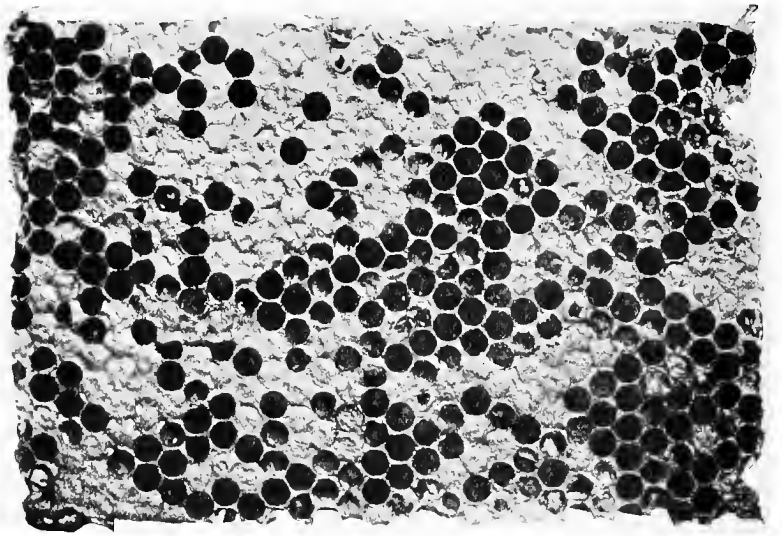


Wired Frame, with Foundation.

Italian preferred. A little feeding with sugar syrup will help the colony to build up quickly. The brood combs of the diseased hive as well as the wraps must be burnt, and the interior of the hive thoroughly scraped. All dirt, wax, and propolis removed by this operation should be carefully collected and destroyed by fire. The hive, internally and externally, should be washed and disinfected. A painter's blow-lamp may be used to fire all infected parts.

Beekeepers who are not disposed to apply this thorough treatment

may adopt the following method :—Shake all the bees off the combs, including the queen, into an old skep or box, and allow this artificial swarm to remain without food for forty-eight hours. At the end of



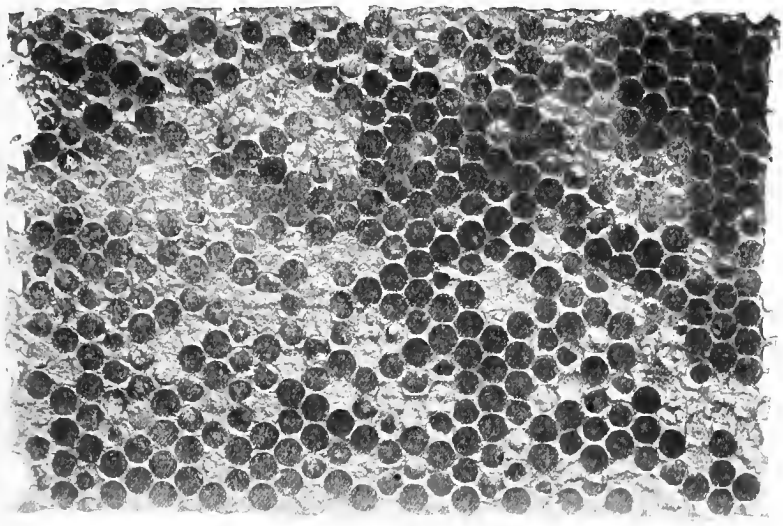
Foul Brood. Second Stage (B. alvei).

this time transfer the swarm to a clean hive, which has previously been fitted with frames into which foundation has been placed. Re-queen either now or in a few days' time. Destroy the receptacle in which the fasting took place.

In both cases it is advisable to destroy the brood combs and quilts. The latter can be easily replaced. The hive, if a good one, should, as in the preceding method of treatment, be carefully scraped to remove all wax and propolis, then washed with soapy water, and afterwards scorched with a painter's blow-lamp in order to destroy any lurking disease spores. If a blow-lamp is not available, the interior of the hive should be painted with methylated spirit and fired, the flames being subdued by means of a wet bag. As before, the material scraped off the hive should be carefully collected and burnt.

Treatment of Foul Brood in advanced stage.—The last stage of the disease is distinguished by the sunken appearance of the cell caps. The internal decaying mass dries into the form of a brown scale, which will be seen at the base or the side of the cell. The colony will have dwindled in numbers, and, as there is no possible cure at

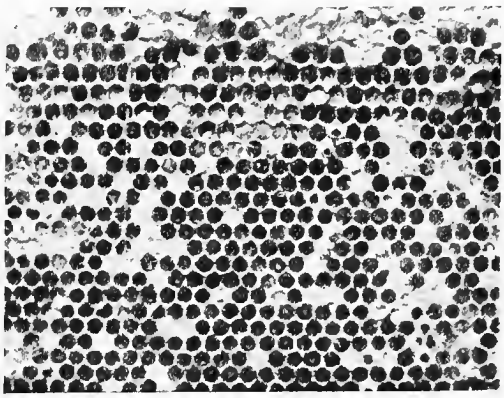
this final stage, it is advisable to destroy by fire the contents of the hive, leaving only the shell for future use. If the hive is an old one it should be burnt as well.



FOUL BROOD. THIRD STAGE (B. ALVEI).

American Foul Brood (Bacillus larvæ).—This disease is not quite so widespread as the other form of Foul Brood. When the larvæ are first attacked they turn a light chocolate colour, and as the disease advances they become darker, resembling roasted coffee in appearance. This disease appears to attack the larvæ at a later stage than the other form of Foul Brood, usually about the time the brood cells are capped over. As the disease progresses the larvæ shrink in size, with the result that the cappings become sunken and perforated. A glance over the brood combs will reveal the presence of great numbers of these cells with indented cappings. Within will be seen the shrivelled portion of the larvæ which have died from the disease. The colour of this diseased mass will be dark brown. If a match is inserted and slowly removed the decomposed material will attach itself to the wood and stretch in a long line before breaking. The decaying matter has a pronounced and rather offensive odour. This disease does not bring about the extinction of the colony as quickly as the other form of Foul Brood, but nevertheless it is fatal in the long run.

Once a colony is attacked, its end is certain unless the necessary remedies are applied.



American Foul Brood.

Treatment of American Foul Brood.—As before, all work should be performed at evening, when the bees have finished flying for the day.

Brush or shake all bees and queen off the combs into a skep or receptacle. Allow them to remain in a fasting condition for forty-eight hours. Then transfer to a clean hive, with frames fitted with starters only. Re-queen with Italian or Dutch strains. Destroy all brood combs and quilts. If the hive is worth keeping, scrape the interior of all wax and propolis, collecting such matter, which must afterwards be burnt. Wash the inside and outside with soapy water, to which a disinfectant should be added, such as Calvert's No. 5 carbolic acid. Scorch the interior of the hive to destroy all sources of infection.

Sac Brood..—Sac Brood is sometimes called Pickled Brood. The larvæ die in the cells, but the remains, instead of decomposing, as in the case of Foul Brood, into a fluid condition, become attached to the side of the cell in the form of a sac. This form of the disease is often confused with the other two forms of Foul Brood, but in this respect the beekeeper need not have any doubt, as the cell-content is odourless. Cappings will also be noticed with minute holes, showing that the work of covering the brood cells was imperfect. Starved or ill-nourished brood would be a better name. A young and prolific queen, together with a new comb or two, will usually effect a cure.

Bulletin No. 105

Dept of Agric.
4/10/1926

The West of Scotland Agricultural College

EXPERIMENTS ON
THE MATING OF QUEEN BEES

CONDUCTED AT

THE APIARY, HOLMES FARM, KILMARNOCK

BY

JOSEPH TINSLEY, F.E.S.

GLASGOW
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1926

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EXPERIMENTS CONDUCTED IN THE MATING OF QUEEN BEES.

The question of the relationship of the queen to the drones in her own hive has been the subject of experiments extending over a period of three years, with a view to solving the problem of pure mating and of making possible the more rapid improvement in the breeds of bees.

It has been an accepted fact by practically all writers of literature on bees that the queen bee is never mated with a drone from her own hive, but always with one from another colony. This statement is all the more remarkable as, so far as we know, no previous research work has been conducted to substantiate it.

It is well known to all bee-keepers that mating takes place in mid-air, and that only one drone is necessary, after which no further mating is required, the queen being capable, under normal conditions, of depositing eggs to populate the hive with her progeny to the end of her life. It is probable that this aspect of copulation has seized the imagination of writers and sustained the assumption that nature has ordained this method to prevent inbreeding. We are told that only the swiftest and strongest drones can catch the queen during her mating flight, while other authorities have contended, without any proof, that drones at the mating season are in large numbers in mid-air waiting for young queens to appear. Our experience does not agree with this latter statement. Other writers contend that the drone is built chiefly for flying long distances, but our experience is that the drone rarely ventures very far away from his own hive.

Our experimental work has been carried out chiefly with the aid of observation hives holding two to three standard combs, similar to those usually exhibited at honey exhibitions. The glasses were so arranged that the movements of the bees could be observed at all times without difficulty. Six of these observation hives were in regular use throughout

the year, and were exhibited at the Highland and Agricultural Show at Glasgow this summer. British, Dutch, Austrian, Italian, and Golden Italian strains were used.

Each hive was stocked with worker bees, worker brood, drones, drone brood, and fertile queen taken from normal colonies. After forming this nucleus of a colony a period of a week was allowed for the bees to settle down and get accustomed to their new home and surroundings. A little food was given. Exits were cut from the lecture room to permit of easy passage for the bees from their hive to the open air, and the inmates were allowed to work as a normal colony. The glass sides which consisted of double thicknesses of glass did not appear in any way to affect the work of the bees. Queens were removed at intervals. Some of the hives were then given queen cells on the point of hatching, others were allowed to rear their own queens, while in other cases virgin queens were introduced.

The following illustration is typical of the majority of our experiments.

The queen was removed from what we will call No. 1 observation hive, consisting of pure Dutch bees, and a ripe queen cell taken from another pure Dutch stock was introduced—allowing, of course, the usual forty-eight hours to elapse before introduction. The virgin queen duly hatched and was accepted by the colony. Curiously enough this event produced no unusual excitement in the hive; the inmates displayed little or no interest in an event which to us seems fraught with importance. The virgin queen at birth is wonderfully active and virile. Her food, we noticed, consisted of honey taken by herself from the honey cells. We found in the majority of cases that usually two days from birth the virgin queen, if the weather was suitable, would leave the hive for a short flight, and again the following day, while in some cases we have observed three flights before the actual mating trip. The average period of these trips was from two to three minutes, and they were invariably taken towards the middle of the day. We have, however, occasionally seen these flights as late as four o'clock in the afternoon.

This action on the part of the virgin queen may be in the nature of a cleansing flight, or to develop the wing muscles, or possibly to familarise herself with the surroundings and enable her to mark her hive previous to the mating trip. The drones in the hive took no apparent interest in these proceedings even when the virgin queen returned. In one instance we observed the workers very loath to allow the virgin queen to return to the hive. Why, we could not tell, but it is interesting to relate that a week later the virgin queen was missing. The workers during the virgin queen's absence exhibited no sign of queenlessness, and, while she was in the hive, no apparent interest was manifested in her. She seemed to be constantly on the move, walking from comb to comb.

To return to the case under notice. Six days from the birth of the queen we found the hive in a highly excited state. Two flights had already been made on the two previous days, but it was now evident that the actual mating flight was about to take place. The weather was fine and warm. At 12 o'clock we noticed the virgin queen hurrying towards the entrance. The drones in this colony were evidently aware of the virgin queen's intention. Some of them were already on the wing, while others were on the alighting board. Attention was at once paid to the other observation hives to discover if any excitement prevailed in them, or if some system of intercommunication bearing on this event existed among them. In the remaining five observation hives, headed with virgin queens and with workers and drones, normal conditions prevailed, with not a drone flying, although the whole were in the same room separated by a few feet only. With the assistance of the students and members of staff a watch was kept at the entrances of the colonies in the immediately adjacent section of the apiary. This section consists of fifty full stocks of bees in W.B.C. hives, and the bees were at the time busy with the storing of honey. These colonies are situated immediately in front of the observation hives, the front row, in fact, being only three or four yards away. Not a drone could be observed either flying or in front of the hive entrances during the period that the virgin queen from

the observation hive was on her mating trip. In all the established colonies nothing but normal conditions was observed. Our observations both in this and many other cases convinced us that the mating of the virgin queen from one hive has no bearing on another, and we can dismiss the theory of any scent connection entirely. The virgin queen returned in three minutes exactly with the drone appendage attached to her abdomen. Two days following her mating trip she deposited her first eggs. Later on we were able to tell from her progeny that she had been mated with a drone from her own hive. A conclusion confirmed the following year when the hive exhibited the general characteristics of this race of bee.

Similar experiments were carried out with British, Austrian, Italian, and Golden Italians, and identical results obtained. There were slight variations in the time of mating and the numbers of flights before mating, but these variations were evidently due, usually, to different climatic conditions.

Practical Mating.

With this knowledge we then decided upon a further practical trial to test the possibility of mating queens with drones from a special colony, at a cost within the reach of the average bee-keeper.

For some considerable time the Bee-keeping Department of the West of Scotland College of Agriculture has been conducting experiments with the various races of bees, more particularly with a view to discovering the most valuable strain of bee suitable for the south and west of Scotland, and for this purpose many colonies of the native race have been purchased from all parts of Scotland. It was the endeavour to obtain pure mating for this scheme that led us to conduct the experiments contained in this report.

For the purpose of this experiment 25 Swiss mating boxes were used. Into each box a pint of Dutch worker bees was placed. The plan adopted to obtain these bees was to " drive " a skep of Dutch bees over a queen excluder, thus preventing queen and drones passing through. The driven bees were then syringed with cold water. This prevented them from

flying and facilitated our work in spooning them out in a mass and filling the mating boxes. Food in the form of sugar syrup was given and the bees securely fastened in with adequate ventilation. These boxes of bees were then placed in a cool dark shed for the night. By morning the bees were perfectly dry, having generated heat during confinement. Previous to this experiment a native colony, purchased some months previously from West Argyllshire, was rearing queens on the cell-cup principle, while another native stock, procured from Arisaig, was being used for mass production of drones—achieved by the liberal use of drone comb.

As all bee-keepers are aware, it is very difficult to make old bees stay in a new location, particularly when their old home is only a few yards away. It was therefore necessary to remove the small mating boxes some distance from the apiary. An old quarry, some two and a-half miles away, was used and the bees transported. On arrival, the entrances were opened, more food given, and at the same time a ripe queen cell was introduced from the queen-rearing colony.

The drone rearing colony was removed at the same time to the mating station. A liberal shaking of the combs in front of the mating boxes gave each a number of healthy strong males. This process was repeated the second day. The weather was not at all ideal for mating, but, notwithstanding this fact, we discovered within a fortnight after the introduction of the ripe queen cells twenty-one of the queens were mated and four missing. Later in the year we were able from the progeny of the queen to prove that all had been pure mated, although within four hundred yards of the station there was a bee-keeper with six colonies of bees comprising Italian and Austrian strains.

We then decided to carry out further tests in the College apiaries to discover the reason for the bee-keeper's contention that queens often mated with alien drones. In a very limited space we have at present 150 colonies of bees of various strains, including British, French, Austrian, Dutch, Italian, and Golden Italians.

We decided to rear a number of queens and mate them in the home apiaries where the queens would have every chance of mating with alien drones. The observation hives were stocked with pure races of bees and queens, but later the queens were removed and ripe queen cells given. In the observation hive containing the British race we observed Italian drones had gained admittance and had been accepted as permanent residents in the hive. We also noticed in other observation hives a casual stranger. This led us to make a close inspection of those nuclei with virgin queens, and where alien drones were noticed a record was made. Examination later in the season, when the young queens were laying, revealed that in 5 per cent. of the nuclei the progeny were related to the alien drones, while in the remaining hives pure mating had been accomplished.

By observations in the late autumn on colonies of bees in possession of virgin queens we had further proof of this feature of mating. Such colonies continued to give sanctuary to their own drones, and we found also that a queenless colony would actually keep drones all through the winter, evidently in response to the instinct to preserve them for the mating of the needed queen. In colonies with mated queens only a few feet away all drones were destroyed; if mating usually takes place with drones from another colony, we should expect colonies with mated queens to keep drones for this purpose.

Conclusion.

Our experiments tend to show that, provided no other drones are admitted to a colony of bees, the virgin queen will mate with her own drones, and it is therefore possible to bring about pure mating or the crossing of queens with any other variety of the same type.

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